Amendments to the Specification:

Please amend the specification as follows:

METHOD FOR MAKING THIN FILM ~~FILTERS~~ FILTER HAVING A NEGATIVE TEMPERATURE DRIFT COEFFICIENT~~AND METHOD MAKING THE SAME~~

[0002] In recent years, thin film filters have often been used in optical systems for signal processing or optical communications. The filters operate to select light of desired wavelengths, often within a narrow band. Thin film filters may be used in association with gradient refractive index (GRIN) lenses and optical fibers to form a dense wavelength division multiplexing (DWDM) device. Referring to FIG. 5, the operating principle of an eight-channel, filter type DWDM device is illustrated. Ideally, a light beam of a particular wavelength is considered one channel. In practice, ~~on e~~ one channel is defined by a very narrow range of wavelengths. The more channels a DWDM device has, the narrower the pass bandwidth of each channel [[is]].

[0004] The coating process is designed to minimize pass bandwidth drift at room temperature (23~~℃~~°C). ~~T he~~ The operational temperature range of a thin film filter is from ~~—5℃~~-5°C to 70~~℃~~°C. Within this temperature range, the stress in the filter varies substantially linearly with the temperature. FIG. 2 shows pass bandwidth of a filter at room temperature. Alcatel's 1915 LMI 10 mw WDM thin film filter has a positive temperature drift coefficient, 1 pm/~~℃~~°C. FIG. 3 shows how the pass bandwidth of Alcatel's 1915 LMI changes with a change in temperature. When the 1915 LMI's temperature increases from 23~~℃~~°C to 70~~℃~~°C, a 47 pm pass bandwidth enlargement occurs, and when the temperature decreases from 23~~℃~~°C to ~~—5℃~~-5°C, a 28 pm pass bandwidth reduction occurs, as is illustrated in FIG. 3. Obviously, since temperature fluctuation and resulting pass bandwidth drift are inevitable, it is preferable if pass bandwidth is reduced more often than it is increased as the environmental temperature changes.

Consequently, referring to FIG. 4, there is a demand for thin film filters having a negative temperature drift coefficient, in which pass bandwidth broadens when temperature decreases and narrows when temperature increases, as shown in FIG. 4. Note that in FIG. 4, the pass bandwidth increases less at the most extreme temperatures than for the Alcatel 1915 LMI case[[,]] shown in FIG. 3.

[0005] Operational temperature fluctuation affects the stress present in a thin film filter, since film stacks and substrates of thin film filters are composed of different materials having different coefficients of thermal expansion (CTE). Thin film ~~stack~~ stacks are deposited on substrates under temperatures substantially higher than room temperature, and then are allowed to cool down to room temperature. If the CTE of a film stack is smaller than that of a substrate on which it is mounted, then the film stack will shrink less than the substrate does as they cool down. Therefore, a convex deformation occurs and a compressive stress is induced in the film stack (see FIG. 1b). This is the case of a stack-substrate combination having a negative temperature drift coefficient.

[0006] In nearly all prior art, DWDM thin film filters have positive temperature drift coefficients. This is the situation illustrated in FIG. 1a. Because the thin film stack is deposited under a temperature substantially higher than room temperature, when cooling down to room temperature, the film stack, which has a CTE greater than that of the substrate on which the film stack is mounted, shrinks more than the substrate does. ~~Theref ore~~ Therefore, a concave deformation occurs. The film stack in this situation is under a tensile stress and pass bandwidth increases as temperature increases, which causes greater susceptibility to crosstalk as temperature increases. The tensile stress endured by the film stack is also a disadvantage during cutting operations, since it makes the affected film layers more brittle, increasing the probability of damage to the film stack during cutting. Furthermore, the adhesion between the film stack and the substrate ~~maybe~~ may be overstressed, resulting in peeling of the film stack from the substrate.

[0009] Two embodiments of the present ~~invented~~ inventive method for making thin film filters having a negative temperature drift coefficient are disclosed. The first embodiment comprises steps of: 1. providing a substrate wafer which has a coefficient of thermal expansion (CTE) greater than that of a selected film stack material; 2. polishing the substrate wafer; 3. depositing thin film layers made of the

film stack material on the substrate wafer at a temperature substantially higher than room temperature; 4. cooling the substrate-film stack laminate to room temperature, thus forming a convex-shaped laminate; 5. cutting the cooled laminate into pieces at room temperature. [[A]] The second embodiment comprises the steps of: 1. providing a laminate composed of a glass substrate and a film stack; 2. using at least one ion beam source to bombard the film stack of the laminate with high energy ions; 3. cutting the bombarded laminate into pieces.

[0013] FIG. 2 is a graph of a thin film filter's spectral transmittance versus wavelength characteristics, showing a pass bandwidth of [[a]] the thin film filter at room temperature (23~~°C~~°C);

[0014] FIG. 3 is a graph of a thin film filter's spectral transmittance versus wavelength characteristics, for the case of a thin film filter having a positive temperature drift coefficient, showing the change in pass bandwidth over the operational temperature range ~~(—5°C to 70°C)~~ (-5°C to 70°C);

[0015] FIG. 4 is a graph of a thin film filter's spectral transmittance versus wavelength characteristics, for the case of a thin film filter having a negative temperature drift coefficient, showing the change in pass bandwidth over the operational temperature range ~~(—5°C to 70°C)~~ (-5°C to 70°C); and

[0018] The first preferred embodiment of the present ~~invented~~ inventive method for making thin film filters having a negative temperature drift coefficient generally comprises five steps as follows: 1. providing a substrate wafer which has a coefficient of thermal expansion (CTE) greater than that of selected film stack material; 2. polishing the substrate ~~wafe r~~ wafer; 3. depositing a stack of films each having a CTE smaller than that of the substrate wafer onto the substrate at a temperature substantially higher than room temperature; 4. cooling the resulting substrate-film laminate to room temperature, thus forming a convex-shaped substrate-film laminate; 5. cutting the cooled substrate-film laminate into pieces.

[0019] ~~I n~~ In the first step, a substrate wafer that has a CTE ranging from 10×10^{-6}/°K to 20×10^{-6}/°K is provided. ~~And the~~ The substrate wafer must be transparent in the telecommunication range, i.e., C band (1528 nm to 1561 nm) and

L band (1561 nm to 1620 nm). The substrate wafer can be made of glass of a SiO_2-Na_2O-K_2O-Li_2O-PbO-XO_2 system, wherein X can be titanium (Ti) or zirconium (Zr). It can also be made of a SiO_2-Na_2O-K_2O-Li_2O-PbO-[[Y]]$\underline{Q}_2O_3$ system, wherein [[Y]] <u>Q</u> can be aluminum (Al), or of a SiO_2-Na_2O-K_2O-Li_2O-P_2O_5-ZO_2 system, wherein Z can be titanium (Ti) or zirconium (Zr). To increase the CTE of the glass substrate to the desired range, the substrate wafer can be doped with lead (Pb), lithium (Li), sodium (Na), potassium (K), or some other alkali ions or oxides.

[0020] In order to increase the adhesion between the film stack and the substrate wafer, in the second step, ~~we polish~~ the substrate wafer <u>is polished</u> to a roughness <u>in the</u> range of from 0.1 nm to 0.8 nm.

[0021] Then, in the third step, ~~we use~~ Ta_2O_5/SiO_2, which has a CTE ranging from 1×10^{-6}/~~°K~~<u>°K</u> to 8×10^{-6}/~~°K~~<u>°K</u>, <u>is used</u> as a material for the thin film stack deposited on the substrate. Each film layer is made of the film stack material, and a chemical vapor deposition (CVD) method is preferred for depositing the film layers on the substrate and on each other. In this step, the substrate and film layers are substantially planar during the layering process. ~~And the~~ <u>The</u> process is conducted at a temperature substantially higher than room temperature.